FLIGHT OF STS–7 WITH ASTRONAUTS CAPT. ROBERT L. CRIPPEN, CAPT. FREDERICK H. HAUCK, COL. JOHN M. FABIAN, DR. SALLY K. RIDE, AND DR. NORMAN E. THAGARD

HEARING

BEFORE THE

COMMITTEE ON SCIENCE AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

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CONTENTS

WITNESSES

July 19, 1983:
Capt. Robert L. Crippen, USN, Commander of STS–7, accompanied by Capt. Frederick H. Hauck, USN, pilot; Col. John M. Fabian, USAF, Dr. Sally K. Ride, and Dr. Norman E. Thagard, mission specialists..... Page 3

FLIGHT OF STS–7 WITH ASTRONAUTS CAPT. ROBERT L. CRIPPEN, CAPT. FREDERICK H. HAUCK, COL. JOHN M. FABIAN, DR. SALLY K. RIDE, AND DR. NORMAN E. THAGARD

TUESDAY, JULY 19, 1983

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, D.C.

The committee met, pursuant to call, at 10:15 a.m., in room 2318, Rayburn House Office Building, Hon. Don Fuqua (chairman of the committee) presiding.

Mr. FUQUA. The committee will be in order. Without objection, cameras and television equipment will be allowed during the proceedings.

The committee is pleased to welcome the crew of the seventh flight of the space shuttle and the second flight of the orbiter; Capt. Robert L. Crippen, commander, pilot, Rick Hauck; mission specialists, Sally Ride, John Fabian, and Dr. Norman Thagard.

The seventh flight of the space shuttle was the most ambitious mission to date, embarking on many notable firsts. It was the first flight to represent private, institutional, and government concerns of several countries, several international payloads that held contributions from Canada, Indonesia, West Germany, and the United States.

It also had seven self-contained experiments carried aboard, dubbed the Getaway Special.

The STS–7 was the first flight to test the potential of the remote manipulator arm in a series of deployment and retrieval exercises conducted by mission specialists Sally Ride and John Fabian, exercises which are vital to the future of the shuttle missions, enabling future crews to deploy, retrieve, and repair space satellites.

Turning now to the composition of the crew, STS–7 contained the first two-time shuttle astronaut, spacecraft commander, Robert Crippen. It carried with it the largest crew to date. Dr. Norm Thagard was assigned to monitor the physiological changes associated with the astronauts' adaptation to space travel.

Finally, and probably the most publicized first, has been the introduction of women into the world of space flight. Dr. Sally Ride became the first American woman to join the NASA flight crew, a step in the continuing success of our space program, enabling the United States to maintain superiority in the arena of space operations.

It is a pleasure to welcome all of you and to congratulate you on a very successful mission. We look forward to your report on the flight and take great pride in adding your names to the list of the successful crews of the previous six flights.

Certainly I would be remiss if I did not acknowledge the support and courage contributed by Virginia Crippen, Dolly Hauck, and Donna Rae Fabian, and also astronaut, Steve Hawley, the husband of Sally Ride. I think you, too, all can take very great pride in these accomplishments.

Before presenting the testimony, I would like to call on our ranking minority member, Larry Winn, for any comments he may wish to make.

Mr. WINN. Thank you, Mr. Chairman. You have covered the subject and the reason for this hearing this morning very well.

I would like to welcome back Bob, who has been before the committee before, and welcome Rick Hauck and John Fabian and Sally Ride and Norman Thagard before the committee. We are very pleased to have you here this morning. We know that you have a very, very busy, busy schedule.

I want to thank all of you for the fantastic job of good PR that you have done, because of the trip, and because of the success of the STS–7.

I was going to kid Steve Hawley a little bit, and I think I will, if you don't mind, Mr. Chairman. I was going to take the opportunity to introduce him, because he is from the great State of Kansas, and I was going to introduce him as Steve Hawley, astronaut, better known in the last few weeks as Mr. Sally Ride.

But I want to say, too, Sally, we appreciate the way that you have handled the unbelievable amount of publicity that has come your way, because you are the first American woman in space. We are proud of you. I have had the opportunity to tell many people that I had you at the University of Kansas about 2 years ago, and the reason you were selected is not because you are a woman, but because you are a damned good astronaut and a mission specialist, and I hope that people remember that. Again, we want to congratulate you. I know the rest of the members of the committee are anxious to ask questions and visit with you. Thank you very much.

Thank you, Mr. Chairman.

Mr. FUQUA. Thank you, Mr. Winn.

Mr. Volkmer, chairman of the Subcommittee on Space Science and Applications.

Mr. VOLKMER. Thank you, Mr. Chairman.

Let me add my congratulations to those of the chairman for a very successful mission and achievement of so many firsts for the space shuttle program.

I have the privilege to serve as chairman of the Space Subcommittee. It is a pleasure to participate in a very small degree in this adventure. As we move forward in expanding our capabilities with the space shuttle, it is comforting to look back over several years when we and NASA said we were going to do something about it and it has been done.

this success are being recognized here today. I join my colleagues in saluting you for a job well done.

Thank you again. I look forward to your testimony today.

Mr. FUQUA. Thank you, Mr. Volkmer.

Mr. Lujan, ranking minority member of the Space Science and Applications Subcommittee.

Mr. LUJAN. Thank you, Mr. Chairman. I want to join you in welcoming the crew up here.

After all the frustrations of the STS-6, it was so nice to see STS-7 go along so smoothly. Of course, we look forward to the future flights, with more things being done and several firsts.

STS-8 I guess will be launched at night, so that will be spectacular. It will have Colonel Bluford on board. That will be another first. STS-9 will have the first foreign astronaut. So after all these firsts, which we have seen and will be seeing later this summer, it may seem strange, but I believe we will be looking forward to the shuttle launches becoming routine. After all, the shuttle should someday become as routine as a flight from Washington to California, which at one time was a first; crossing the Atlantic, which also was a first at one time. These trips have become relatively routine. I also hope that the space shuttle flights someday will be routine. However, I think flying the space shuttle will still be a lot of fun.

Welcome to the committee.

Mr. FUQUA. Thank you.

Commander Crippen, we are happy to hear from you and the members of your crew.

STATEMENT OF CAPT. ROBERT L. CRIPPEN, USN, COMMANDER OF STS-7, ACCOMPANIED BY CAPT. FREDERICK H. HAUCK, USN, PILOT, COL. JOHN M. FABIAN, USAF, DR. SALLY K. RIDE, AND DR. NORMAN E. THAGARD, MISSION SPECIALISTS

Captain CRIPPEN. Thank you very much, Mr. Chairman, members of the committee. It is indeed a pleasure for me to be here the second time to report on the flight of the seventh mission of the space shuttle in orbit.

With regard to being routine, I would like to add one little comment that I obtained from Sally's father-in-law: "Obviously we have become as routine as the airlines when we can land on one coast and have our launching be on the other side."

Actually we have progressed considerably. Since the last time I had the opportunity to testify before this committee, if I could have predicted to you at that time that we would be where we are now with respect to the space shuttle, I would have been happy to do so, but I would have thought I would have been too optimistic.

The flight of STS-7, as you indicated, Mr. Chairman, was very optimistic as far as the kinds of things we set out to do. It was pretty much of an international mission with respect to launching communication satellites for Indonesia, for Canada, for putting up a satellite that was built in West Germany, and which also allowed us to do things like proximity operations, test out the capability of the space shuttle to fly near a satellite in orbit, as well as numerous other experiments.

What I would like to do today is to have each of the members of my crew give you a brief synopsis of a particular aspect of the mission. I would like to start off with Dr. Thagard to tell you a little bit about the space adaptation syndrome.

Dr. THAGARD. Well, Mr. Chairman and members of the committee, if it was mentioned I guess I missed it, but my own wife, Kirby is here today. Glad to have her with me.

As you probably know, after flight 5 it was decided to add an astronaut position to flights 7 and 8, to study the problem of space adaptation syndrome. Basically I performed experiments falling into two groups. The principal investigator for most of those experiments is Dr. Bill Thornton, who is going to fly on flight 8.

The two principal theories have to do with fluid shifts which basically says that in zero G, fluid redirects to the upper parts of the body. Perhaps it leads to increased pressure inside the head, which can produce certain symptoms that have been seen in earlier space flights.

The other theory, and perhaps the one with the most occurrence has to do with sensory conflicts, which says it is the changed relationship between the vestibular system and the body's vision sensors that produces some unknown stress that causes the symptoms of space adaptation syndrome.

Without going into a lot of detail on the results, which by the way are still being evaluated, and were preliminary, primarily for the purpose of gathering data to lead us eventually toward a possible cause and then solution. we performed all the experiments—I don't think we missed any of them—and we got lots of data. It is now being analyzed and I hope that we are on the road to at least the cause for space adaptation syndrome, and hopefully following shortly after that, its prevention or treatment, once it occurs.

Unless you want more detail, I think that concludes my part.

Captain CRIPPEN. Sally Ride.

Ms. RIDE. OK.

We also carried the Canadian-built remote manipulator system, a 50-foot-long arm, again on this flight. It had been used on several previous flights, but we tested out a new capability of the arm, which is going to be a very important capability for the space shuttle. We used it to not only deploy but also retrieve a satellite.

On flight day five of our flight, both John and I used the arm to unberth the SPAS, the German payload, release it as a free flyer into orbit, and then Crip and Rick flew the shuttle to perform proximity operations, using the SPAS as a free flyer and the orbiter in conjunction with that.

Then John and I both used the arm at various times during the flight. I think we made a total of five captures, demonstrating the capability of the arm to capture a free-flying payload and demonstrating the capability of the orbiter to retrieve satellites. That is going to be very important in the future of the space shuttle program.

One comment about the capabilities of the arm. We all found it very easy to use. We found it a very satisfying system. Dynamically it was very stable, and we had no problems at all with it. We think it is going to be a great addition to the shuttle program.

Colonel FABIAN. Mr. Chairman, members of the committee, on the first day of the flight, STS-7 deployed an ANIK satellite, a telecommunications satellite for the Canadian Government. We did this approximately 9 to 10 hours into the flight profile and found that the shuttle and crew were perfectly willing and able to make

that deployment at that time. As a matter of fact, we think that you could deploy telecommunication satellites earlier in the flight profile even than that. The following day we deployed the Palapa satellite for Indonesia.

In both cases, the performances of the space shuttle was such that all of the specifications which NASA is responsible for deployment of telecommunications satellites were far exceeded. As a matter of fact, we promised to deploy these satellites within 2° accuracy of the desired pointing, and that was less than one-half a degree in pointing accuracy. So we feel that the space shuttle is in fact extremely well designed and developed to this point to do one of its most important tasks on orbit, and that is the deployment of satellites with upper stages going to geosynchronous orbit.

Captain HAUCK. Mr. Chairman, committee members, as has already been mentioned, on day five we did deploy the SPAS German satellite, to conduct proximity operations. This was a first in the space program in that we were able to fly the shuttle in close proximity to a free-flying satellite. It is very important to us to understand the interactions between the shuttle and satellites nearby, because of our intent in the future to fly in close proximity of other satellites, both in deployment and retrieval.

We are interested in how easy it was to station-keep, how efficiently we could do that with the use of our consumables, and also to see what the interaction was between the firing of our reaction jets that we used to control the altitude of the orbiter as they are fired in the vicinity of the satellites.

In the morning phase, Crip flew it in station-keeping and a departure out to 1,000 feet and station-keeping out at 1,000 feet, and we found that the orbiter was very easy to control, very easy to position, and it was much less taxing than we might have thought it would be from our simulations, and we found it very efficiently done.

Mentioning simulations, we found those were very important to us, if you will, making it look easy on orbit. It was very important for us to train very hard back in Houston to make it look easy. It is hard to do something that involves as much coordination without having an opportunity to train on it on the ground.

In the afternoon, we conducted what we called our plume data survey, where we fired the reaction jets at the SPAS. The data will come back from Germany as to the reaction of the SPAS to those firings. But at least from the subjective standpoint, looking out the window, there was very little interaction. In the future I am sure we will be interested in trying that with a bigger payload, but at this point we think that worked very well.

We concluded the proximity operations by flying what we call an inertial approach, allowing us to fly out of the orbit plane, around the SPAS at a 200-foot distance, and closing in on it and regrappling it there. And in all of the operations we were very pleased to see that our estimates of fuel usage for the reaction control system was right on target. Our simulations trained us well for that, and we were very pleased with the results.

Captain CRIPPEN. And with respect to the proximity operations, members of the committee may be aware that NASA is undertaking an attempt to rescue and repair the Solar Maximum satellite,

which is in space at this time. It has had a problem with its altitude control system. I have been given the honor of commanding that flight, which is flight No. 13, which is supposed to fly next April, where we will utilize the capability of flying in close proximity, so we can send somebody out on a maneuvering unit to stabilize it and then we will maneuver the orbiter and grapple it with the same arm we just talked about and attempt to repair it and redeploy it, and if we are not successful with that, to go ahead and retrieve it and bring it back to Earth to repair it.

In addition, I would also like to comment, with a crew of five and the four fantastic crew people I had to fly with, we also found out that that made the operations much easier in space. It was not crowded. The volume we have aboard the Challenger allows at least a crew of five and maybe even more, and it was a plus as far as our operations are concerned.

One other comment. I apologize to Congressman Nelson for not having an opportunity to return the Challenger directly to Florida. That had been our intent. But unfortunately, somebody wasn't helping us with the weather that day. I do think that it does prove the flexibility of the system to change its mind very rapidly and have a recovery in California. It also perhaps added a small plus in that we found out we can recover the orbiter with a much smaller convoy, fewer people, smaller amount of equipment, which will perhaps help us reduce some of the turnaround cost in the future.

Without any further ado, I would like to share with the members of the committee the small home movie, much as John and I did on our first attempt, to give you a little bit better insight as to what the flight was like from our perspective.

Colonel Fabian, while we are waiting, I might mention all of us participated extensively in the training for taking pictures in orbit. We were very pleased with the results.

That is our mission patch. We have come to like that design very well.

Here is pad 39, down at the cape, early in the morning. Some clouds rolled over the top of us but left just as we were counting down to ignition, which you see here. We are very pleased to launch on time. Three main engines lighting off. Once they are up to a past 90 percent, the sequence allows the solid rockets to go, and off we go. John Fabian was sitting in one of the seats behind me. He said he was able to look over his shoulder and see the ignition of the main engines and the system around it.

This is a beautiful shot as day breaks, climbing up through the clouds. I have been told by the folks that watched it from the outside, that it was a beautiful setting.

The simulators prepared us very well for the ride, not any different from what we had been told by the people that had flown before. With the solid rockets strapped aboard during the first 2 minutes you certainly knew you were going somewhere, and you were confident it was in the right direction. A little bit of rattling, a little bit of shaking, but really very smooth.

We were all monitoring our instruments and making sure that eveything was going well. Since it performed so beautifully, we had no objections to make.

You are going to see solid rocket motor separation here. Beautiful shot from long-range TV. I am told the solid rockets were retrieved and will be reprocessed.

First shot on orbit. The doors were opened and we passed over the Mexican coast. Pretty view of clouds and the ocean from space.

You will get an introduction again to the crew here. This is Bob sitting in the commander's seat, making inputs to the CRT. Rick Hauck looking out the window. Dr. Norman Thagard. Dr. Sally Ride observing the view. The fifth crew member here is coming up to take a look outside.

One of our most important tasks was the deployment of the two telecommunication satellites. Here you see the sunshield opening at the rear of the cargo bay exposing the Palapa satellite.

We have the sunshield open. The first thing we do to get ready for the deployment is to get the satellite spinning. We spin it at 50 revolutions per minute in order to gyrostabilize it for the first of the rocket firings which will put it into geosynchronous orbit. In every case the Palapa satellite and the associated PAM performed flawlessly.

Here you can see, we are just about to push it out. And there goes the Palapa spacecraft. Notice how straight it tracks up the vertical tail. That is very important, because pointing is very vital to the success of the spacecraft deployment.

Comdr. Bob Crippen was at the aft station. At that time, he took a hand-held 19-millimeter camera and took this shot of the Palapa spacecraft as it is departing the orbiter. And here it is at an even greater distance out over the Earth's horizon.

Captain CRIPPEN. Both the ANIK and Palapa are on station and operating correctly.

Ms. RIDE. What you just saw there was a shot of the ignition of the orbiter maneuvering system, the OMS, that we used to accelerate the orbiter just after the deployment of the satellites.

What you are seeing here is me down on the middeck operating the electrophoresis experiment sponsored by McDonnell Douglas and Johnson and Johnson. It is part of their program for the production of pharmaceuticals in space. I am putting the syringe down at the bottom of the column. It contains the sample they hope to process. The sample is injected into a buffered solution, and an electric field is applied across it which enables it to separate the protein, the desired samples, from the rest of the buffered solution and the sample. Collection is performed at the top of the column. That apparently has been very successful. They are going to be flying it again on the next flight.

Dr. THAGARD. Well, this is Commander Crippen on the treadmill. Dr. Bill Thorton invented that treadmill and wanted some 17-millimeter photos of folks using it. Here we have the pilot, Rich Hauck. Everyone was scheduled to do this except for myself. I was the doctor and the only one who didn't exercise on the mission.

In a previous sequence I was holding a DC amplifier in my hand. That was part of the electro-oculargrams, which was looking at the sensory conflict theory of the space adaptation syndrome.

John Fabian has our microbial sampler. The program is to determine what the microbial makeup on the shuttle is, both in the mid-

deck and the flight deck, early in the mission and then just before coming home.

Sally is getting her exercise there on the treadmill. And now we will see that equal opportunity does not apply when it comes to peanuts. Rick had gone after some peanuts for himself and Sally got them instead.

Rick, why don't you take this one?

Captain HAUCK. I am going over to our head, or bathroom. There is a lot of interest in how we had a little privacy up there. We are demonstrating that it really worked very well. The curtains were easily rigged there. We were afforded as much privacy as you could ask for.

We are getting ready now for the deployment of the SPAS satellite on the fifth day of the mission. We are using here the remote manipulator system to raise the SPAS up out of the cargo bay. This task was very smooth and offered no surprises at all to us in terms of controlling RMS.

The SPAS was built by MBB, a German corporation. They did a very, very good job in providing us a spacecraft which not only had their own experiments in it, but provided the capability for doing all of the proximity operations that were planned for the mission.

You can see how smooth the maneuver is. Here is an aft station view with Bob Crippen and I, Norm Thagard in the background. Here is a TV release of the SPAS satellite. Again, you can see it when you maneuver the arm back of the satellite to release it, there is very, very little motion. We observed no residual motions at all on the SPAS satellite as we released it. And here we are getting ready for some proximity operations work.

Captain CRIPPEN. We were beneath the SPAS and we started backing out away from it. We are 200 feet below it. We had some cameras aboard the SPAS which allowed us to get some fantastic shots. At that point we did have a radar, which was the first time it was flown, that provided us with range and range rate. We executed out in front of the SPAS and we are a thousand feet in front of it now. We station-kept there for several hours. Very stable. All of that is done manually, and I could go over a half hour without making an input to it to maintain our stability out there. So it is going to be a fantastic flying machine as far as proximity operations is concerned.

We are probably about 600 feet out at this particular point. The radar did perform very well for us and made the tasks much easier from our standpoint, since it took out the guessing game as to how far out we were. We did start closing after a couple of hours. We did stay overnight, since it was a couple of hours. You see the flashes. Those are the X thrusters which are about 900 pounders.

That is what it looks like from the cockpit. It does sound like there is a small war going on outside when you are in the process of doing something like this, but from a matter of control, it was no problem at all. When you are moving something as large as the shuttle around, which is a little over 200,000 pounds here, somehow it is about the best way you can do it.

You can maneuver with very slow rates. As we came in very slowly to set up for the capture, we turned it back over to John after we stabilized it.

Colonel FABIAN. This is the first real retrieval of a satellite we had earlier released and immediately regrappled. Again, the RMS performed very, very well. What you are seeing there are oscillations about a quarter of an inch amplitude. You can see how easy it is to control the RMS in completing that task.

Ms. RIDE. Rick and I did the proximity operations and arm working during the second half of flight day five. Right now, you are looking at a camera mounted on the SPAS, on the satellite with the satellite still attached to the arm. I am actually rotating the arm which is moving the camera on the SPAS, scanning down the payload bay.

The thing that you see most forward in the payload bay right now is the OSTA-2 pallet, which carried materials processing experiments.

This gives you an idea of the kind of time we had while we were up there.

Captain HAUCK. Here we are backing away, firing the jets at the SPAS. I might mention this is a fairly labor intensive time. Sally and I are in the aft cockpit, as you see there. But John is up in the forward left seat, the commander's seat. Monitoring SPAS is helped through the telemetry, and Crip was in the pilot's seat making sure that the orbiter was doing what it was supposed to do and also being the manager of the scenario, reading the check list, making sure we are on schedule. Norm was doing a fantastic job of taking some of these pictures.

Here is the inertial approach. We are flying up and over SPAS. Beautiful cloud formations passing underneath.

You are looking through the sight there used for station-keeping. And here we are continuing that flight over at about 200 feet and pretty soon we will start to close it.

This entire operation, complete with a lunch break, involved about 10 hours of our workday. We worked 16-hour workdays up there, but the time surely went quickly. When it was time to go to bed, I think most of us were a little bit disappointed.

Sally, over to you. You can talk about bringing it back aboard.

Ms. RIDE. Rick is still flying the orbiter at this point. The orbiter is about 100 feet out away from the SPAS. He will be flying the orbiter until it is roughly 30 feet from the SPAS, using the RMS camera as a guide. When he sees that the SPAS is stable looking through the camera, then he puts the orbiter in free drift, and I start flying the arm. Here you see the arm moving in toward the grapple fixture on the satellite. Notice how well behaved the arm is. And there is the grapple right there.

Captain HAUCK. This is a fantastic picture that John Fabian took. Remember that color. That is the color of the hot plasma outside the spacecraft as we reenter the Earth's atmosphere. Here is a sunrise. We did our deorbit burn over Australia in the dark. It was not until we approached the California coast we saw daylight again.

This is a ground-based shot, 50,000 feet over Edwards Lake bed.

Although it was a disappointment not to get into the cape, it was great to see the Edwards terrain down there. That is a fantastic backup facility for us. I am sure it will continue to be.

This picture of Crip taken from over his left shoulder. His head appears to be jerking. He was not nervous, that was just the frame rate the camera was taking the pictures.

Rolling onto the final approach, a picture we are all familiar with from TV, about 15,000 feet, we are doing about 330 miles an hour, coming down. And Crip had already taken over manual control of the orbiter at this point. I am monitoring altitudes and airspeeds. Sally is monitoring what both Crip and I are doing.

Coming down, looking at that black triangle on this side of the lake bed, you see some lights we used to orient ourselves. We are grounding at about 2,000 feet, and slow down to touch down, about 220 miles an hour. The landing gear was put down at 200 feet, and Crip brought it in over the lake bed, a nice shallow approach.

We had plenty of runway out there, and touched down just slightly in excess of 200 knots. I wasn't even sure we were down at that point, it was so soft. Kept the nose up until about 180 knots, and then Crip flew the nose back down to the ground and with some very slight braking, again because we were on the lake bed with plenty of runway, we decelerated to a stop.

It wasn't until after we got out of the orbiter we found out there was a problem with one of the brakes there on the right side. But it was never apparent during our braking. We are looking closely into that and seeing what can be done to remedy it.

Captain CRIPPEN. I would like to acknowledge a gentleman who is with us here today that made that type of approach possible with his work back on the X-15, Scott Crossfield. We are still using his techniques. You still get low and fast coming in over the lake bed, Scott, and it works just as well as it did during those days.

The machine was in good shape. They did do a rapid turnaround as far as I am concerned, and got it out of there in 5 days.

You notice I ended up at center line. That is not exactly where I landed. But since that is where we take all the pictures, where you stop, we marked to land there.

With that, Mr. Chairman, that concludes our testimony.

Mr. FUQUA. Thank you, Bob.

I might just say, not to take away from your fantastic flight, but this weekend Scott Crossfield is being inducted into the Aviation Hall of Fame. We are really proud of that.

It appears from the way you made it look, both John and Sally, that the retrieval of the Solar Max is just going to be a real cup of tea. It looks like the concern we had, certainly you have demonstrated it is not going to be the problem once anticipated.

Captain CRIPPEN. We hope, every indication we have of this flight it will be a doable task. As John Young told me, the way you make something look easy is practice, practice, practice, and that is what we plan on doing between now and April. It should be pointed out the SPAS itself does have its own attitude control system which maintains the stability and also allows us to control it via our RF link if we need to.

While the Solar Max does have a means of controlling certain axes, it is also out of control about other axes. That is one of the reasons we were interested in this plume data, seeing what the results of the jets firing themselves were going to have on the SPAS,

and that data is still being looked at, although all indications are today we do not anticipate that is going to be a problem.

Mr. FUQUA. Mr. Winn.

Mr. WINN. Thank you, Mr. Chairman.

John, what would be the advantage of deploying communication satellites earlier? You mentioned that in your testimony.

Colonel FABIAN. Well, Mr. Winn, we have in the past been a bit concerned about the crew workload on the first day of any of the shuttle flights, because there is a certain period of time associated with adapting to the environment in which you must work. The experience that we have is that the period of adaptation that has been allowed is perhaps longer than is really necessary.

Now, if we could get one of the satellites up a couple of revs earlier, that might mean that we could deploy two telecommunication satellites on the first day of the flight, which obviously would have its advantages in terms of overall efficiency of the program. So that was the reason for making the comment.

Mr. WINN. Maybe you can tell me, or Sally, did they make any changes in the Canadian arm from the STS-6 to the one on STS-7?

Ms. RIDE. No; they did not. We flew the same arm that had been flown on previous flights. We did fly a new end effector. But it was essentially the same, an identical design. It was just their second in the production line.

Mr. WINN. This is not a silly question, but I think most of the people in the room would be very interested in what Sally Ride is going to be doing and what her reaction is going to be when Steve Hawley flies on the STS-12 and she is on the ground?

Ms. RIDE. I am going to be a very interested observer.

Mr. WINN. Thank you very much, Mr. Chairman.

Mr. FUQUA. Mr. Volkmer.

Mr. VOLKMER. I would like to get a little more detail for my understanding of the maneuvering of the shuttle at the time of placement of the SPAS. We all saw it. Did you move ahead of it to a distance of 1,000 feet?

Captain CRIPPEN. Let me go through a little bit more detail. We started out below it, and we started a very slow departure and maintaining thrusters to maintain directly beneath the SPAS. And when we reached 200 feet, we took advantage of something that orbital mechanics does for you. If you have one satellite flying beneath another one, the one at the lower altitude it tends to go faster. And this is strictly something due to physics. It does go faster, and consequently we quit firing to try to maintain beneath it and let the orbital mechanics effects take advantage, which started to go in front of it.

At that time I started rotating the orbiter so I could maintain visual sighting continuously on the SPAS. And we used the radar, which had already locked on at that particular point, to see when we got out to 1,000 feet. When we got out to 1,000 feet, I stopped my opening rate by firing thrusters again and fired some thrusters to allow me to come up again to the same altitude. And when I reached the same altitude, again maintaining approximately 1,000 feet, I fired thrusters to stabilize our position.

It was at that point, once you stabilize it, it is what you refer to as station-keeping. In some way it is related to flying formations with an airplane, except you are putting in little discrete inputs.

One of the things that made that a very simple task was the radar did perform so well for us. We were not out very far, 1,000 feet. It is not very far in terms of radar. We are interested in how it is going to perform on future missions like Solar Max.

Mr. VOLKMER. Now, you are 1,000 feet ahead of it. How do you get back, since you are in the same orbit speed now?

Captain CRIPPEN. We are at the same orbit speed. We get out in front of it at the same altitude. That is a stable orbit, as we refer to it. Since you are at the same altitude, you tend to travel at the same speed. It does not require manual inputs to the thrusters themselves.

After we had continued the time that we wanted to station-keep, we fired thrusters to start us back coming toward it. When you fire thrusters to start you back at something that is behind you, that actually slows you down, and when you slow down, it tends to make the orbit want to go lower, because that is the same technique we use when we are ready to deorbit and come in.

Since we are slowing down, we also have to fire thrusters to continually hold our altitude up. So that is again, just a matter of the pilot sitting there making the correct inputs. Once you started coming at something, then what you have to do is continually or periodically fire thrusters up to maintain that same altitude. The closer we get, we start slowing down the rate at which we are approaching. We refer to those as breaking gates.

For example, when we are out 1,000 feet we started coming at it 1 foot per second. When I got to 500, I slowed that down to one-half a foot per second; 400, four-tenths of a foot per second, on until we got down to a little less than two-tenths of a foot per second.

Mr. VOLKMER. When you started slowing down, what was the altitude of the orbiter in relation to the SPAS?

Captain CRIPPEN. The thrusters are on the front and the back. We are using both of those.

Now, we were flying tail down with respect to the Earth. We put the control system in a mode that allowed it to keep its tail pointed toward the Earth. We are looking out the overhead windows at the SPAS itself. Now, the thrusters actually are going out in all directions from the orbiter, and one of the things we are concerned about is we don't want the thrusters to directly impinge on anything that we are flying.

Consequently, we have a control mode, once we get very close—and we use 200 feet—we change the control mode such that for braking purposes, we did not fire thrusters directly at the SPAS itself, but we took advantage of the fact that the thrusters on the ends of the orbiter are slightly canted toward the top of it, and we use those to do the final braking. That also is very expensive as far as fuel is concerned, so we wanted to make minimum use of that. But from everything that we can see, it did not use much fuel and it was very responsive and it did not look that it caused any effect on the satellite we were trying to retrieve.

Mr. VOLKMER. So you really see no problem next April with the Solar Max?

Captain CRIPPEN. I see no problem from what we have investigated thus far. We still have some investigation to do, but we can do it with ground simulations.

Mr. VOLKMER. Thank you very much.

Mr. FUQUA. Mr. Lujan.

Mr. LUJAN. Thank you, Mr. Chairman.

I was going to ask Colonel Fabian, are you the tallest amongst all the astronaut trainees?

Colonel FABIAN. No sir, I am not. I think 6 foot 4 is the tallest. We call him the "Ox."

Mr. LUJAN. Most of what you described to us, operational experiments—Dr. Ride, you did mention the electrophoresis experiment, and materials processing.

Ms. RIDE. Yes; we had some materials processing experiments out in the payload bay.

Mr. LUJAN. What other things did you carry? Ants?

Ms. RIDE. We carried the ants. We had seven get away specials that were out in the payload bay that had minimum crew involvement. We turned relays on and off to activate or deactivate experiments. We had seven of those. Some were flown by high school students, some from foreign countries—Germany—some from the naval research laboratory.

Mr. LUJAN. The reason I ask is, usually during committee hearings when we are talking about going into space stations and all of those things, we have to wait to determine what we are going to do with it before we make that decision, and everybody talks about the materials work and the electrophoresis work, and they always say "and others." But I very seldom hear what the "and others" are.

Ms. RIDE. Some of the other experiments we are carrying were aboard the SPAS. We used it not only as a platform for the proximity operations, as a satellite, but also as an experiment platform while it was still in the cargo bay. It has one experiment called the yaw sensor experiment that was designed to detect the yaw angle of the orbiter as it was moving around in the orbit by photographing the Earth as it went by to see how the Earth slides by under its viewer. So that was something that they hope to apply to space navigation later.

We also had materials processing experiments on crystal growth on that experiment pallet.

Mr. LUJAN. So that is probably the major use—the crystal and that sort of thing—is probably the major uses that we would have in space?

Ms. RIDE. Of the materials sequence, I think semiconductor production, crystal growth. Also, high temperature containerless processing. Since it is weightless—we compared, for example, an acoustic levitator that held—it was sound waves that held the material sample suspended while it was heated, so it wasn't touching any sides of a container.

And this is something that is very important in high temperature processing, because with high temperatures you tend to get contamination resulting from the sides of the container. As the container is heated, the sides of the container essentially melt into the sample you would like to keep pure.

Colonel FABIAN. You might find some of the other SPAS experiments interesting as well. We had a heat pipe experiment on board which was intended to evaluate one on one several different types of heat pipe designs and heat pipes are very useful devices because they allow you to take thermal energy that you don't want to take away from certain parts of the spacecraft and send it out into space via radiators.

In addition, we had an experiment on board to evaluate different types of solar cell materials. Solar cell materials came from countries around the world and were on board the SPAS, as again kind of a fly off type activity.

Really, I think one of the most interesting aspects of the experiments on board the SPAS was an experiment that has no space applications at all. That was a device to measure the frictional aspects of flow inside of pipes. The reason that that was done in space is that when you try to measure the coefficients associated with such a phenomenon on Earth, the gravitational effects always predominate. In order to get better engineering designs for very large factory applications on Earth, it was necessary to take that type of an experiment into space, get very accurate mesurements of those frictional coefficients, and then come back into an Earth environment for the application.

I think that, quite frankly, there are a lot of potential activities in space that don't have direct space applications, but in which space is the best place to get the measurement.

Mr. LUJAN. One final question. Is STS-8 being held up because of something about how TDRSS is operating? What connection is there?

Captain CRIPPEN. I am not sure exactly what you are referring to, sir. But the STS-8 is not holding for TDRSS. TDRSS was supposed to have flown aboard flight 8, the second TDRSS. That is not going to happen because of the investigations that the Air Force is still doing with respect to the malfunction that we had with the IUS, the booster that was to take it up to geosyncronous orbit. Consequently, they remanifested flight 8 to take up a large test facility to do some more work with respect to the remote manipulater.

In addition to that, flight 8 was already manifested with another communications satellite, one from India, which it is also carrying. So flight 8 is progressing as planned, and is going to be going off the latter part of August.

Mr. LUJAN. When will the second TDRSS go up?

Mr. CRIPPEN. The second TDRSS schedule is dependent on what happens with respect to the IUS. It is currently manifested for flight 12 which is scheduled in the March timeframe, and that is still being looked at due to the test work that the Air Force is doing and we may have to modify that schedule somewhat.

Mr. LUJAN. Thank you, Mr. Chairman.

Mr. FUQUA. Mr. Harkin.

Mr. HARKIN. Thank you, Mr. Chairman.

Captain Hauck and Colonel Fabian, you were both pilots before, were you not, Air Force and Navy?

Colonel FABIAN. That is correct.

Mr. HARKIN. But the other two were not?

Ms. RIDE. I was not.

Dr. THAGARD. I was a Marine fighter pilot.

Mr. HARKIN. I see. You are an M.D., though?

Dr. THAGARD. I am an M.D.

Mr. HARKIN. There has been a lot of stuff in the news media about speculation about people on the shuttle suffering from vertigo. Did any of you get vertigo on this flight at all? Did you notice any?

Dr. THAGARD. I don't know vertigo has been a particular problem for us. Our policy has been if it didn't have mission impact that crew health was essentially a private matter. On our flight, no one at any time was unable to do what they were supposed to do at the time they were supposed to do it.

The problem with space adaptation syndrome is not so much what has happened as the potential. The problem is, it is a thing that occurs in the 1st day to 3 days and by the third day if anyone has it they are usually over with it at that time. The problem is, of course, shuttle flights are only 5, 6, 7 days long. So if you have something that is going to interfere it could interfere for potentially half of a mission for some people.

So it has not been a major problem for us, but the potential exists. That is why we really need to study it and understand what is going on.

Mr. HARKIN. So nobody got sick on this flight?

Dr. THAGARD. No one got operationally impaired on this flight.

Colonel FABIAN. One of the comments I made—it doesn't deal with medicine. I pointed out that I think that on the 1st day we could have done our first deployment earlier and perhaps could have done two deployments that day. While I am not allowed to talk about the health of the crew members, I think that the implications of that are quite clear.

Mr. HARKIN. Colonel Fabian, what did you find to be the most difficult in terms of your own personal adaptation?

Colonel FABIAN. I guess the most difficult thing to me was adapting to that thing which we cannot practice on Earth, and that is moving around, getting used to the mobility that you have when you don't have a gravitational field. It took an hour or an hour and a half before I really felt comfortable moving about and doing my job with no gravity, making sure I had myself properly restrained at all times when I was trying to do some task.

Mr. HARKIN. Ms. Ride, all of these people were former fighter pilots.

Ms. RIDE. Kind of terrifying; isn't it?

Mr. HARKIN. We wonder about the future of our country.

You were not. You had some experience, I know, in flying T-38's I guess it was, or something before. But did you have any more difficulty than the other members in adapting to zeroing?

Ms. RIDE. No; I don't think that that really has any bearing at all. I had no light plane experience before I came to NASA. Since I have been there, I have about 15 hours a week in the 38's as we all have. Although I think that the T-38 flying is very valuable in terms of learning coordination, learning radio techniques, navigation techniques, and appreciating the job that the pilots have in the space shuttle, I don't think that it is necessarily important to adaptation in weightlessness.

Mr. HARKIN. What was your biggest difficulty?

Ms. RIDE. I agree with John. I think when you first get up there you are very inefficient, you feel a little bit clumsy, and it can be frustrating, just because you want to get on with the job, but you are in such an unfamiliar environment that it is difficult to do.

Mr. HARKIN. Thank you very much.

Mr. VOLKMER. Would the gentleman yield on that?

Let me ask you, the second time around, Bob, was it easier than the first time around as far as the weightlessness and the use of it?

Captain CRIPPEN. I was pleasantly surprised. On my first flight I had the experience of the same thing both John and Sally spoke of. But again, that is a short-lived phenomenon. It probably takes a half hour to two hours really to start to build up some efficiency. This time I felt as soon as I climbed out of my seat like I was back home again. It was no problem at all as far as adaptation to zeroing.

Mr. VOLKMER. You basically knew what to expect?

Captain CRIPPEN. Yes. It is a matter of learning how to control your body and when you need to grab hold of something and when you don't.

Mr. HARKIN. What G's do you get on liftoff and reentry?

Captain CRIPPEN. Maximumn G's experienced during powered flight is three. It is like you are laying on your back. On entry it is very mild. I think we saw 1.6 or 1.7, much like you would get on an airliner coming into National Airport, when he is coming in on a final turn.

Mr. HARKIN. That is less than the capsules.

Captain CRIPPEN. Much less. It was designed to be that way, primarily not from the crew standpoint, but for the satellites we were going to carry, so they wouldn't have to be beefed up structurally so much.

Mr. FUQUA. Mr. Walker.

Mr. WALKER. Thank you, Mr. Chairman.

Just a couple of questions about a couple of problems. The school kids all over America want to know what happened to the ants.

Captain CRIPPEN. I am afraid we are not qualified to answer what happened to the ants. I am being told that they were documenting what the ants were supposed to be doing in zeroing. Some of the documentation, the film did say that some of the ants were at least alive when we were in zeroing.

They were inside the cannister for several months prior to flight, and also for quite a while after we got back down. While that was not the primary objective of that particular experiment—it was really designed to stimulate the minds of some of the youngsters in Camden, N.J., with regard to science, and with respect to that, I think that really shows the complete success of that particular experiment and the people that sponsored it are to be congratulated, in my opinion.

Mr. WALKER. You mentioned in discussion of the film the brake problem you had upon landing. Has there been any determination as to what caused that problem and is there a fix that has been undertaken on it?

Captain CRIPPEN. That is still being investigated today. There was some speculation it had to do with dissimilar materials used in

various portions of the brakes causing irregular heating and some swelling. The brakes have had minor problems on just about every flight to some extent, but never the same type of problem. We have some people looking into that extensively at this particular time.

Mr. WALKER. Thank you, Mr. Chairman.

Mr. FUQUA. Mr. Nelson.

Mr. NELSON. Thank you, Mr. Chairman.

Yesterday, Jim Beggs had some interesting news. He said that he is optimistic that the White House, within the next 6 to 12 months, will give the go ahead for a space station. If that in fact turns out, Bob, I wanted to ask you, since you have been twice and have operated this vehicle, do you see it adapting well in the transportation system of supplying a space station?

Captain CRIPPEN. Congressman Nelson, I certainly hope what he spoke of comes to pass. If you can recall from the previous testimony that Captain Young and I gave to this committee, that was our recommendation at that time. We believe that that is the next logical step. Of course, it is just a step. If we want to go back to the Moon, if we want to go to Mars, anything that we are going to do further out, we need a space station to make that happen.

And I am convinced that it is not a matter of "if." It is a matter of when. This country is going to build one at some time, and it is only a matter of when we get our priorities together to decide that is what we should do.

With regard to the shuttle, I think it has proved time and time again it is the type of vehicle that is going to allow us to launch repeatedly at a fast turnaround rate. It has a cargo size that is perfect as far as I am concerned to design a modular space station and to supply it while it is up there.

Mr. NELSON. Do you have any feeling as to what should be the second generation shuttle?

Captain CRIPPEN. I would be speculating from my own personal standpoint. The improved avionics, taking advantage of the state of the art that we currently have available. Obviously we perhaps could even work on a horizontal launch, which would have some advantages as far as operational capability. I do know there are various studies but nothing really looking at it that hard. I believe that is where we should be focusing at this time.

I think we need to take advantage of the shuttle we have to move out and do something like a space station and then to a space tug.

Mr. NELSON. Did I understand that you landed manually? Is that the first one we have totally landed manually?

Captain CRIPPEN. No, sir, all of them have been totally landed manually.

Mr. NELSON. I was under the impression most of them were brought down to 1,000 feet and then gone back on instruments.

Captain CRIPPEN. We have gone manual at various locations. When I said "totally," maybe that is misleading. I took over at approximately 45,000 feet, which was essentially over the base, shortly after we had gone subsonic. Most of the hypersonic, supersonic phases are done automatically, with a crew monitoring, and we have taken over at various places during those after hypersonic, to put in various test maneuvers.

From the pilot's standpoint, if you can go ahead and take over when you are at fairly high altitude, it gives you a little bit more time for hands on experience with the way the vehicle is performing. We think from the standpoint of what the final product is, you end up with a better one.

We have done test flights, trying to stay in automatic until very low. It is NASA's attempt to develop a fully autoland capability for the space shuttle. However, the proper way to do that is with the correct steps. We still are working on when we are probably going to take it to a full autoland to a touchdown. I think the current plans are looking at somewhere around the 14th flight.

Mr. NELSON. And then if the gremlins in the sky around Cape Canaveral fog us in again, with a full auto-land system, you can bring it in.

Captain CRIPPEN. No sir. One of the things about an auto-land system, from the pilots standpoint, is that you have to be able to intervene at any point. Otherwise, you are totally dependent on some simplex kind of failures that could put you in a very bad situation. It would be nice to be in a position such that if you were to come into Kennedy, and you were committed and you did run into bad weather, you would have an auto-land system there to help you out. But I don't believe we would be in a position for quite some time as far as I am concerned.

One of the things that could be disastrous is thunder storms. We are an all electric flying machine. You don't want to put it in a position of getting strikes from lightening. I think you would feel the same way about any airliner you are riding in. The additional thing is raindrops. Rain can get very hard on the tiles that we have. All of those factors add up to looking at the weather.

Mr. NELSON. Thank you, Mr. Chairman.

Mr. FUQUA. Thank you.

Mr. Carney.

Mr. CARNEY. Thank you, Mr. Chairman.

I would just like to congratulate the five members of STS–7 for a job well done.

I would like to direct a couple of questions specifically to Captain Crippen and Captain Hauck, simply because they piloted the STS–7.

I think, and of course I am a novice, you, Captain Crippen, quoted John Young as saying the best thing here is practice, practice, practice.

Captain Hauck, you said it is hard to do if you didn't practice on the ground as frequently as we did. And we are in a test flight scenario here with the shuttle. We are on a learning curve. The proficiency of the pilot and the commander is very, very important.

I was wondering, would we not serve the program better if we continued to use the same pilots and commanders because of the accumulated experience that they would get as opposed to changing the commander and pilot as frequently as we do. And I know that in the case of Captain Crippen, you will be flying another time. That would be 3 out of 13. But I was just wondering if by not making so many changes, we would improve the proficiency of flying the machine.

Captain HAUCK. Well, your point is well taken. But we do have a flight rate that we are looking at that is going to accelerate very rapidly, and it is important to us in NASA to insure that we broaden our experience base as rapidly as possible, with the tradeoffs that you mentioned about increased training time.

The flight rate we are looking at 3 or 4 years from now, we really need to develop this broad experience base now so that we can take advantage of that in the not too distant future.

Captain CRIPPEN. I guess I can echo what Rick is saying.

We are trying to find out how fast we can turn around people and refly them. I am perhaps an example of that. One of the problems is that you cannot put together a crew like this and have them working as individuals and then throw them together at the last minute and go produce a flight like we have just flown. You have to work it together as a team for some period of time prior to that. Consequently, that does mean training together. So you cannot just take somebody that has been out flying yesterday, throw him in with a new crew with a complete new mission he doesn't understand, without working together for a while.

I am optimistic that we could certainly fly somebody twice a year. If you were flying a mission that was essentially the same thing or again, like going up and deploying some communication satellites, probably even three times a year. But that would be a very high flight rate.

As Rick pointed out, we are talking about 24 times a year. We are normally going to be working with crews of five or even more. And that takes a lot of people. That is why we are trying to increase our experience base.

Mr. CARNEY. In essence, you agree with the scheduling, then. What you are saying is you have to give up something to gain something else.

Captain CRIPPEN. We have to look toward the future. We cannot just look at today.

Mr. CARNEY. Thank you.

Thank you, Mr. Chairman.

Mr. FUQUA. Mrs. Lloyd.

Mrs. LLOYD. Thank you very much.

I have no questions. I would like to tell you we are all very proud of you and congratulate you for a mission well done. We are proud of all of you—I think the fact remains the majority of the women in this country had an extra feeling of pride and accomplishment when Dr. Ride took the big trip with you. We are proud of you, and we are proud that a great lady did make the ride.

Ms. RIDE. Thank you. I appreciate that.

Mr. FUQUA. Mr. Andrews.

Mr. ANDREWS. Thank you.

I would like to ask Dr. Ride if she would communicate a little bit more about the arm itself and its capabilities. Because of the success of this mission, do you anticipate any expanded experiments?

And second, have you made any recommendations for changes in the arm?

Ms. RIDE. We have made no recommendations for changes in the arm based on our experience. There are some minor changes that are planned which basically add a redundancy to the arm, not ad-

ditional capabilities to it. Capabilities that if something went wrong, we could still perform the flight.

We did do quite a few tests on our flight with the arm to investigate its dynamic characteristics and also to investigate contingency capabilities. We did a couple of different grapples of the free flying payload using contingency modes.

For example, the second tracking capture I did was what we call a single joint tracking capture, if you move the arm joint by joint rather than with the hand controllers controlling just the tip of the arm. Normally, we look out the camera on the end effector and just essentually fly the camera in. We can maneuver the cameras as appropriate. And that proved to be very easy.

The one that I did was moving the arm one joint at a time, so rather than having the full motion of the arm you are forced to move the elbow, then the wrist, then the shoulder. That is something you might have to do if you had lost some of the other capabilities of the arm. We had no problem with that. We found that that was much easier than anticipated.

We also did one where we lost or we were able to evaluate the case where we lost the camera on the end of the arm. We feel that would also be feasible. So we did quite a few things that kind of expanded what we thought the capabilities of the arm were. We were very pleased.

Mr. ANDREWS. Thank you very much.

Thank you, Mr. Chairman.

Mr. FUQUA. Mr. Lewis.

Mr. LEWIS. Thank you, Mr. Chairman.

I don't have any questions, Mr. Chairman. I am very proud to be a member of this committee. I am a new member. Under your leadership it is obvious that the space program has moved so well. I guess today I just feel I am very proud to be an American and look at Americans sitting out here and the tremendous accomplishments they have made and hope to be a part of for many years in the future.

Mr. FUQUA. Thank you.

Mr. Chandler.

Mr. CHANDLER. Thank you.

Bob, I would like to follow up on the questions about the weather. Suppose that you found yourself in a situation where neither the California landing sight nor the Florida was available. What are the options that are available to you in cases like that?

Captain CRIPPEN. We normally design missions to allow us at least a two day extension capability with respect to the consumables that we have on board. The limiting factor is the amount of hydrogen we are carrying that helps produce the electricity for our fuel cells. So we have the option of extending.

The other one is that we do have a third recovery sight here in the United States which we used on flight 3, the one at White Sands, N. Mex., north of the strip. So all of those options are available. If things got down to dire straits we have various places around the world we could land the vehicle if that became necessary.

Mr. CHANDLER. Thank you.

Dr. Thagard, I was intrigued by the shots of the work on the treadmill. Did you find there is any difference in a person's endurance, ability to physically exercise there in weightlessness?

Dr. THAGARD. You are probably going to have to ask someone that actually used it. I was the only one in the crew that did not use the treadmill, which is kind of surprising because I would venture to say I was probably the one that exercised the most preflight.

I think that the endurance in zero G is probably at least initially the same as one G. There is going to be a de-conditioning process simply because zeroing is not much work. It is really a low stress environment, doesn't require much in the way of muscle power. I think it is a place where finesse does you a lot better than pure power does.

Mr. CHANDLER. Thank you very much.

Mr. FUQUA. Thank you.

Mr. MacKay.

Mr. MACKAY. Thank you, Mr. Chairman.

I was interested in the comments about the space adaptation syndrome. You said that is not the same as vertigo. I guess for a lay person, we think of motion sickness. Where is NASA in the study of space adaptation syndrome, how does it differ and what percent of the astronauts have experienced it?

Dr. THAGARD. First of all, space adaptation syndrome probably is not a single thing, it is a spectrum. That is one reason for calling it a syndrome. Symptoms that have been seen range from things that seem very much like sea sickness to headache, to just overwhelming fatigue, loss of motivation. What has actually happened has varied from individual to individual.

I think the instance in shuttle has been seen to be about 40 to 50 percent roughly. The interesting thing is, I think we are all well motivated and in spite of the way some crew members may have felt on flights, most folks have gone right ahead and done their jobs. It has not generally been an incapacitating thing.

Again, the worry was because it can involve up to 50 percent of the time of a short shuttle mission. You could conceivably one day lose something as a result. We have gathered a lot of data now. There have also been vestibular studies going on in past programs and it has continued in the shuttle. We just expanded it a little bit with some broader tests, and looking at flight shifts a little bit more than perhaps has been looked at in the past.

Mr. MACKAY. I wasn't sure I understood Colonel Fabian correctly—was what you were saying if you had been able to function more quickly or adapt more quickly, that more work could be programed into the earlier part of the flight?

Colonel FABIAN. No, sir, that wasn't what I was saying. We have within our launch time line a 3-hour period which is intended to get the spacecraft set up for on orbit activity. We call it our postinsertion period. Inside of that postinsertion period we have little or no activities directly associated with the payloads. During that period of time, I think everybody adapts very well to the zeroing environment—one-half-hour, to 2-hour time period is required.

What I was pointing out is that then after the 3-hour period associated with postinsertion activities, I think you could start hard

into payload related activities and do deployment earlier than we have done in the past.

Mr. MACKAY. That question came right after a question bout space adaptation syndrome. I thought your answer was related to that in some fashion.

Colonel FABIAN. No, sir.

Mr. MACKAY. Thank you.

Mr. FUQUA. Thank you very much, Mr. MacKay.

Crip and Rick and John and Sally and Norm, we want to thank you again for being here. I congratulate you on a most successful flight. We are sorry we missed you at the landing.

Mr. VOLKMER. One quick question.

You brought back this time the SPAS. That has been the largest thing we brought back so far, right?

Captain CRIPPEN. We have flown even on flight 2 a large radar unit that was there, and even on flight 1 we had some development instrumentation which was like 3,000 pounds in the payload bay. Really, this was not all that much heavier. We were a little—about 205,000 pounds, which is about what several of the flights have been.

Mr. VOLKMER. Thank you.

Mr. FUQUA. Again, we thank you very much and congratulate you on a most successful flight. We are very proud and pleased for you.

Thank you.

The hearing is adjourned.

[Whereupon, at 11:55 a.m., the hearing was adjourned.]

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